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(54) **Screw equipment for digging to construct diaphragms**

Schraubenvorrichtung für den Aushub zum Schaffen von Schlitzwänden

Équipement vissé pour creuser afin de construire des diaphragmes

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Description

[0001] The subject of the invention is a screw equipment and a method for digging to construct diaphragms.

[0002] Diaphragms are underground vertical walls created for the purpose of impermeabilizing an underground void (e.g., the basement of a building, an underground station, a tank, the area downstream of a dam, etc.) from any lateral infiltration of water or other fluid and for supporting the soil of the walls.

[0003] Said diaphragms are made by digging and filling in individually adjacent panels with reinforced concrete.

[0004] Each panel has a vertical development that can extend for more than fifty metres and can have a cross section having the shape of a rectangle or a rectangle with semicircular shorter sides or ends. The equipment for digging to construct said diaphragms is referred to as clamshell bucket or grab.

[0005] Traditionally, clamshell buckets are made up of two opposite leaves provided with teeth, which, with a rotation of less than 90 degrees each, remove and gather soil from the bottom of the digging (see Figure 1). Set above the leaves is a body with side walls that rest upon the walls of the digging so as to limit any deviation of the digging itself from the vertical direction.

[0006] In hard soils, clamshell buckets can work by percussion in order to penetrate better.

[0007] Said operation, however, is not allowed in urban areas on account of the vibrations that are produced, with possible harmful consequences for nearby buildings and disturbance of public peace.

[0008] The soil gathered by the clamshell bucket is then hauled up to the surface by hoisting the entire loaded bucket, using a rope system, and then emptying the bucket by opening the leaves.

[0009] However, the soil compressed between the leaves of the clamshell bucket is difficult to detach, and systems of expulsion are necessary to facilitate the manoeuvre, which otherwise would require percussion of the open bucket against the surface of the worksite.

[0010] This operating cycle hence comprises long unproductive steps of lowering, hoisting and unloading. In order to exploit the working cycle better, it is of fundamental importance to increase the amount of debris transported during each cycle.

[0011] The geometry of the leaves of the clamshell bucket, however, does not enable an unlimited increase in the internal volume.

[0012] As an alternative to buckets, continuously operating systems have been studied, in which breaking down of the soil is carried out by milling wheels and conveyance of the soil to the surface is carried out by pumping a jet of water with the debris suspended therein. The water is, then, poured back into the digging after separating off the solid part in order to resume the cycle of extraction of debris.

[0013] Milling wheels may be drums with horizontal axes (see Figure 2) or front disks with vertical axes (see Figure 3).

[0014] An example of tools with vertical axes is also the one described in the patent No. US 5,007,770; this embodiment, however, aims principally at supporting the walls using a formwork and is consequently limited in depth by the height and weight of the device.

[0015] It can be readily understood that continuous systems are much more costly, since they comprise systems for pumping and separation, which must be powerful and sophisticated in order to convey and separate all the soil that is dug out at the same rate at which it is broken down.

[0016] A purpose of the present invention is to propose a device for digging to construct diaphragms with a digging cycle of the first type, i.e., intermittent, with low costs and without sophisticated systems, characterized by a high loading capacity and absence of vibrations.

[0017] Another purpose of the invention is to preserve the possibility of making very deep diggings, typical of rope-suspended systems.

[0018] For the above and further purposes that will emerge more clearly understandable from what follows, the invention envisages providing a screw equipment and a method for digging to construct diaphragms as described in claims 1 and 2.

[0019] The device and the method according to the invention will now be described with reference to the attached plates of drawings, in which:

- Figure 1 illustrates a traditional clamshell bucket;
- Figure 2 illustrates a traditional mill for digging with milling wheels made up of drums with horizontal axes;
- Figure 3 illustrates a traditional mill for digging with milling wheels made up of front disks with vertical axes;
- Figure 4 illustrates the digging device according to the present invention; and
- Figure 5, 6 and 7 illustrate three shapes of diggings which can be obtained using the device according to the present invention.

[0020] Continuous-screw digging equipment is known and its use is very widespread. Said equipment breaks down the soil ahead of it and conveys it to the surface with a screw-conveyor system, which is able to contain a large amount of soil. Such systems, which were initially used for soft soils, have undergone a development that renders them suitable and highly productive even in soils that contain stones and soft rocks. The system is substantially quiet and without any vibrations.

[0021] It is, however, digging equipment that is used for carrying out in soil cylindrical diggings with diameters that are substantially the same as the diameter of the screw itself.

[0022] The device according to the present invention (see Figure 4) is made up of a plurality of substantially vertical tubes 1 set alongside one another, each contain-

ing a screw 2. The top end of the screw is set in rotation by a motor assembly 3, whilst the bottom end 5 is provided with appropriate tools for breaking down the soil 4.

[0023] The bottom end 5 of each screw projects from the bottom mouth of the corresponding containment tube 1 and has a diameter larger than that of the tube itself so as to dig a cavity into which the tube 1 can conveniently sink, following the screw 2.

[0024] In order to limit the tendency of the equipment to deviate from the vertical direction or to descend screwing into the soil, the individual screws 2 must rotate in pairs in opposite directions.

[0025] The motor drive 3 of the screws can be a single one, with drive systems for the individual screws, or else multiple, with separate motors for each screw.

[0026] The length of the tubes 1 and of the screws 2 is such as to guarantee a large accumulation volume, which is limited only by the hoisting capacity of the crane which manoeuvres the equipment and by practical limits of encumbrance and transportation. Also the unloading stage is facilitated since it is sufficient to turn the screws in the direction opposite to the loading direction, which is obtained preventing any impact and any environmental disturbance.

[0027] The cross section of the digging would thus appear as a series of circles 8 set alongside one another or slightly interfering with one another (see top side of Figure 5). Said section can readily be transformed into a rectangle with semicircular shorter sides using radiusing blades or additional mills 6 (see bottom side 9 of Figure 5). It can also be transformed into a true rectangle, using the aforesaid radiusing blades 6 and other end blades 10 with a sharp edge as additional mills.

[0028] The action of percussion of the cutting blades 6, 10 against the fringes of soil is not necessary, since the front section of said fringes is modest and since windows 7 are made in the tubes for collecting the soil in front of the area of action of the aforesaid cutting blades. In this way, the debris that has detached from the blades finds a way of expansion in the windows.

[0029] Alternatively, the equipment according to the invention can be built in two parts of which one, namely the outer one, which has a rectangular layout, can slide on the internal one and is designed for a limited action of percussion around the digging. The internal part comprises the screws and containment tubes. Its function is that of digging, gathering and conveying the debris.

[0030] In addition, the equipment may also be configured as illustrated in Figure 7, i.e., made up of two separate bodies, the outer one 11 of which can slide, by means of guides 12, on the inner one, which is made up of the aforesaid tubes 1.

[0031] The internal body, which, as has been seen, is made up of screws and tubes, has the task of collecting and accumulating the soil, whilst the external one 11, which can be actuated as a bit in so far as it is provided at the bottom with appropriate tools, can be connected to the rope-hoisting system and has the function of cutting the soil along the boundary of the cross section of digging.

[0032] When the outer body 11 is lifted to be pulled out, the inner one slides on the guides 12 until a mechanical end-of-travel element is encountered and is then, in turn, hoisted out.

[0033] In this way, there is no longer any need to apply to the tubes the radiusing blades 6 and 10 illustrated with reference to Figure 4, 5 and 6, in so far as it is the outer body 11 that delimits the rectangle of digging.

[0034] It is evident that what has been described herein is a rectangular digging in so far as this is the most traditional shape employed, but it is understood that by suitably arranging the tubes set alongside one another, the radiusing blades 6 and 10, or else the outer body 11, it is possible to obtain an infinite number of configurations of the equipment as regards its cross section.

[0035] The advantages of the solution proposed by the invention as compared to the known art are evident:

- Higher digging efficiency in a wide range of soils
- High capacity for loading debris
- Absence of any vibration
- Ease of unloading
- Large digging depth

[0036] In addition, as compared to the solution referred to above in the patent No. US 5,007,770, the present invention consists of a device having a limited height and is lowered using ropes to greater depths, the only limit being the amount of rope that can be accumulated on the winch.

Claims

1. Method for digging to construct diaphragm walls in the soil with a plurality of intermittent digging cycles by means of an equipment constituted by a plurality of substantially vertical tubes set alongside one another (1), each containing a continuous screw (2), the top end of each screw being set into rotation by means of a motor assembly (3) whilst the bottom end (5) is provided with appropriate tools for breaking down the soil (4), the equipment being periodically hoisted out of the excavation by a rope system to and from depths greater than a length of the vertical tubes; each working cycle including the steps of loading, temporary storing and unloading the debris of the excavated soil;
   the loading of the debris into the tubes being obtained turning the screws (2) in the excavating direction;
   the temporary store of the debris consisting in the whole inner volume of the tubes (1);
   the method being **characterized in that** the unloading of the debris out of the tubes is obtained turning the screws (2) in the direction opposite to the loading direction.

2. Equipment for digging to construct diaphragm walls in the soil with a plurality of intermittent digging cycles by means of an equipment constituted by a plurality of substantially vertical tubes set alongside one another (1), each containing a continuous screw (2), the top end of each screw being set into rotation in the excavating direction by means of a motor assembly (3) whilst the bottom end (5) is provided with appropriate tools for breaking down the soil (4); the equipment being periodically hoisted out of the excavation by a rope system to and from depths greater than a length of the vertical tubes; the turning of the screws (2) in the excavating direction causing the loading of the debris into the tubes, the whole inner volume of which (1) representing the temporary store of the debris;
characterized in that the screws (2) can also be turned in the direction opposite to the excavating direction causing the unloading of the debris out of the tubes.

3. Equipment according to claim 2, in which the whole inner volume of said tubes (1) represents the temporary store of the debris loaded into the tubes by turning the screws (2) in the excavating direction, **characterized in that** the volume of said tubes is limited by a hosting capacity of an hoisting machinery manoeuvring said equipment.

4. Equipment according to claim 1, **characterized in that** fitted on the tubes (1) is another body (11) and an inner body; said outer body (11) sliding on guides (12); said inner body being made up of said tubes (1).

5. Equipment according to claim 1, **characterized in that** the individual screws (2) rotate in pair in opposite directions.

6. Equipment according to claim 1, **characterized in that** it is rope suspended.

Patentansprüche

1. Grabeverfahren zur Schaffung von Schlitzwänden im Erdboden mit einer Vielzahl von intermittierenden Grabezyklen mittels einer Vorrichtung, bestehend aus einer Vielzahl von im Wesentlichen vertikalen Röhren (1), die längsseits zueinander angeordnet sind, jeweils aufweisend eine durchgehende Schraube (2), wobei das obere Ende jeder Schraube mittels einer Motoranordnung (3) in Rotation versetzt wird , während das untere Ende (5) die passenden Werkzeuge zum Aufbrechen des Erdbodens aufweist, wobei die Vorrichtung periodisch durch ein Seilsystem aus der Grabung herausgezogen wird, in und aus Tiefen größer als eine Länge der vertikalen Röhren; wobei jeder Arbeitszyklus die Schritte beinhaltet:

   - Laden;
   - temporäre Lagerung; und
   - Entladen des Aushubs des ausgegrabenen Erdbodens;

   das Laden des Aushubs in die Röhren wird durch Drehen der Schrauben (2) in Graberichtung erreicht; wobei das temporäre Lager des Aushubs aus dem gesamten inneren Volumen der Röhren (1) besteht; **dadurch gekennzeichnet, dass** das Entladen des Aushubs aus der Röhre heraus durch das Drehen der Schrauben (2) in die Richtung entgegengesetzt zur Laderichtung erreicht wird.

2. Grabevorrichtung zur Schaffung von Schlitzwänden im Erdboden mit einer Vielzahl von intermittierenden Grabezyklen mittels einer Vorrichtung bestehend aus einer Vielzahl von im Wesentlichen vertikalen Röhren (1), die längsseits zueinander angeordnet sind, jeweils aufweisend eine durchgehende Schraube (2), das obere Ende jeder Schraube wird mittels einer Motoranordnung (3) in Rotation in Graberichtung versetzt, während das untere Ende (5) die passenden Werkzeuge zum Aufbrechen des Erdbodens aufweist, wobei die Vorrichtung durch ein Seilsystem periodisch aus dem Aushub herausgezogen wird in und aus Tiefen größer als die Länge der vertikalen Röhren;
das Drehen der Schrauben (2) in Graberichtung bewirkt das Laden des Aushubs in die Röhren hinein, wobei das gesamte innere Volumen dieser Röhren (1) das temporäre Lager des Aushubs repräsentiert, **dadurch gekennzeichnet, dass** sich die Schrauben (2) auch in Richtung entgegen zur Graberichtung drehen können und ein Entladen des Aushubs aus den Röhren heraus bewirken.

3. Vorrichtung gemäß Anspruch 2, in der das gesamte innere Volumen der Röhren (1) das temporäre Lager des Aushubs repräsentiert, das durch das Drehen der Schrauben (2) in Graberichtung in die Röhren geladen wurde,
dadurch gekennzeichnet, dass das Volumen der Röhren begrenzt ist durch eine Aufnahmekapazität einer Hebevorrichtung, die die genannte Vorrichtung manövriert.

4. Vorrichtung gemäß Anspruch 1,
dadurch gekennzeichnet, dass auf den Röhren (1) ein weiterer Körper (11) aufgesetzt ist; wobei der genannte äußere Körper (11) gleitend auf Führungen (12) ist; wobei der genannte innere Körper aus den genannten Röhren (1) gebildet wird.

5. Vorrichtung gemäß Anspruch 1,
dadurch gekennzeichnet, dass die einzelnen

Schrauben (2) paarweise in gegengesetzten Richtungen rotieren.

6. Vorrichtung gemäß Anspruch 1, **dadurch gekennzeichnet, dass** es seilgehalten ist.

Revendications

1. Procédé de creusement destiné à la construction de cloisons dans le sol avec une pluralité de cycles de creusement intermittents au moyen d'un équipement constitué d'une pluralité de tubes sensiblement verticaux disposés les uns le long des autres (1), chacun contenant une vis continue (2), l'extrémité supérieure de chaque vis étant mise en rotation au moyen d'un ensemble moteur (3) alors que l'extrémité inférieure (5) est munie d'outils appropriés pour la désagrégation du sol (4), l'équipement étant périodiquement relevé hors de l'excavation grâce à un système de câbles grâce à un va-et-vient à des profondeurs supérieures à une longueur des tubes verticaux ; chaque cycle de travail incluant les étapes de chargement, de stockage temporaire et de déchargement des déblais du sol en cours d'excavation ;
le chargement des déblais dans les tubes étant obtenu en faisant tourner les vis (2) dans le sens de l'excavation ;
le stockage temporaire des déblais consistant en l'intégralité du volume interne des tubes (1) ;
le procédé étant **caractérisé en ce que** le déchargement des déblais hors des tubes est obtenu en faisant tourner les vis (2) dans le sens opposé au sens du chargement.

2. Equipement de creusement destiné à la construction de cloisons dans le sol avec une pluralité de cycles de creusement intermittents au moyen d'un équipement constitué d'une pluralité de tubes sensiblement verticaux disposés les uns le long des autres (1), chacun contenant une vis continue (2), l'extrémité supérieure de chaque vis étant mise en rotation dans le sens de l'excavation au moyen d'un ensemble moteur (3) alors que l'extrémité inférieure (5) est munie d'outils appropriés pour la désagrégation du sol (4) ; l'équipement étant périodiquement relevé hors de l'excavation grâce à un système de câbles grâce à un va-et-vient à des profondeurs supérieures à une longueur des tubes verticaux ; la mise en rotation des vis (2) dans le sens de l'excavation provoquant le chargement des déblais dans les tubes, dont l'intégralité du volume interne (1) représente le stockage temporaire des déblais ;
caractérisé en ce que les vis (2) peuvent également tourner dans le sens contraire au sens de l'excavation, ce qui provoque le déchargement des déblais à l'extérieur des tubes.

3. Equipement selon la revendication 2, dans lequel l'intégralité du volume interne desdits tubes (1) représente le stockage temporaire des déblais chargés dans les tubes en faisant tourner les vis (2) dans le sens de l'excavation, **caractérisé en ce que** le volume desdits tubes est limité par une capacité de levage d'une machine de levage manoeuvrant ledit équipement.

4. Equipement selon la revendication 1, **caractérisé en ce qu'**un corps extérieur (11) et un corps intérieur se trouvent emboités sur les tubes (1) ; ledit corps extérieur (11) coulissant sur des guides (12) ; ledit corps intérieur étant composé desdits tubes (1).

5. Equipement selon la revendication 1, **caractérisé en ce que** les vis individuelles (2) tournent par paire dans des sens contraires.

6. Equipement selon la revendication 1, **caractérisé en ce qu'**il est suspendu à des câbles.

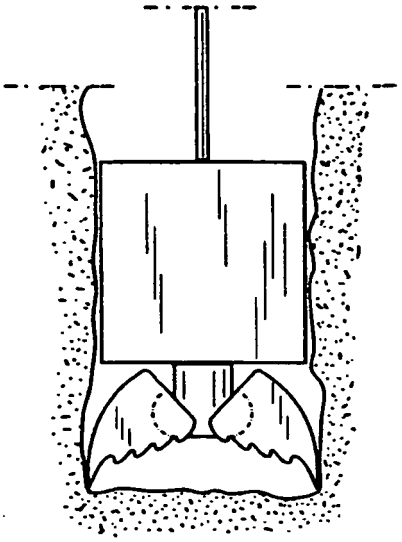

Fig. 1

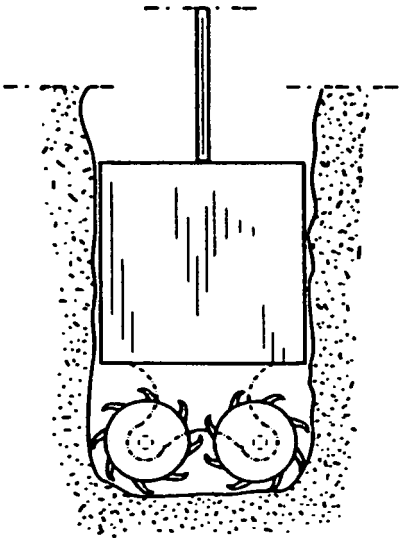

Fig. 2

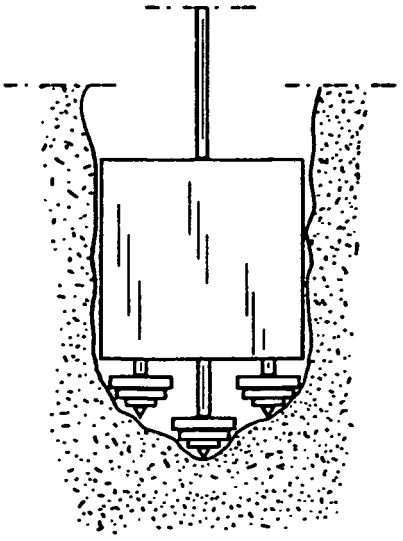

Fig. 3

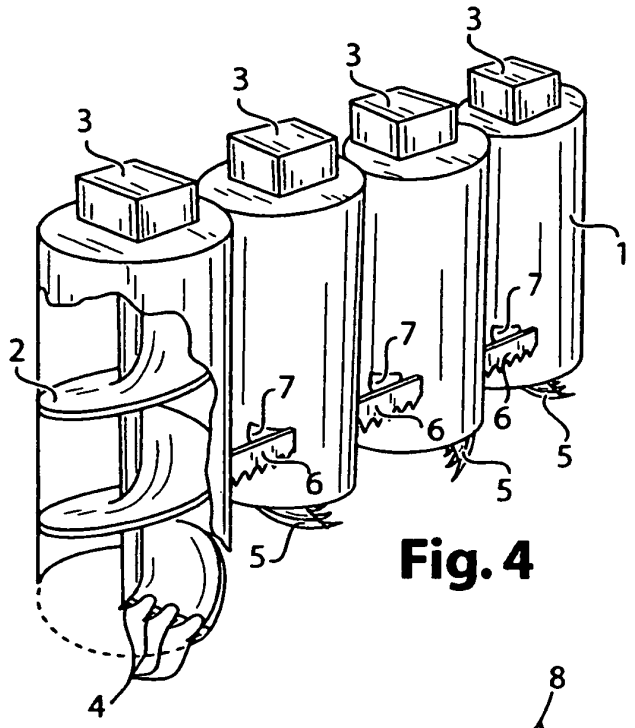

Fig. 4

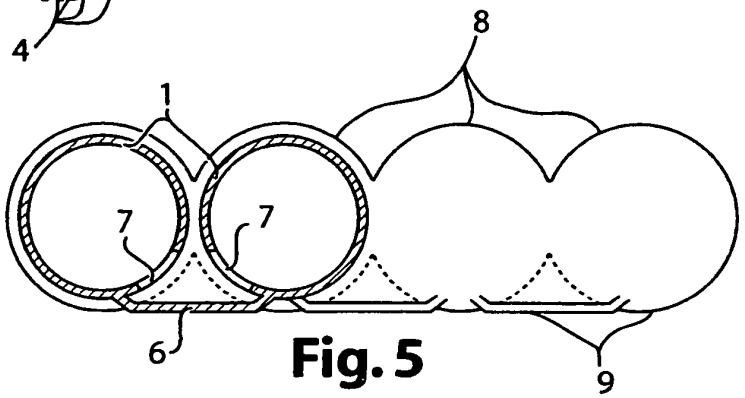

Fig. 5

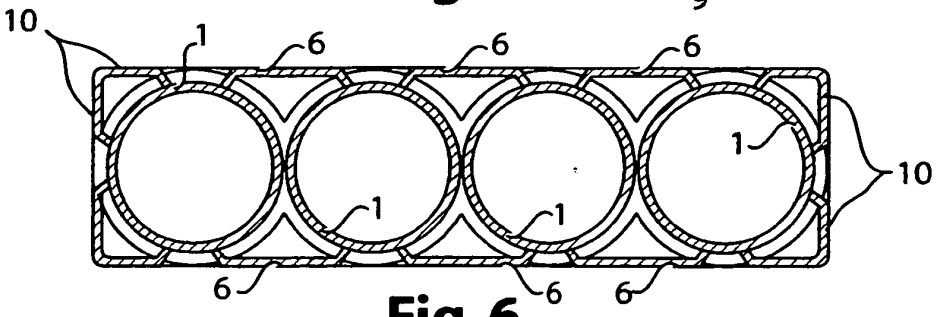

Fig. 6

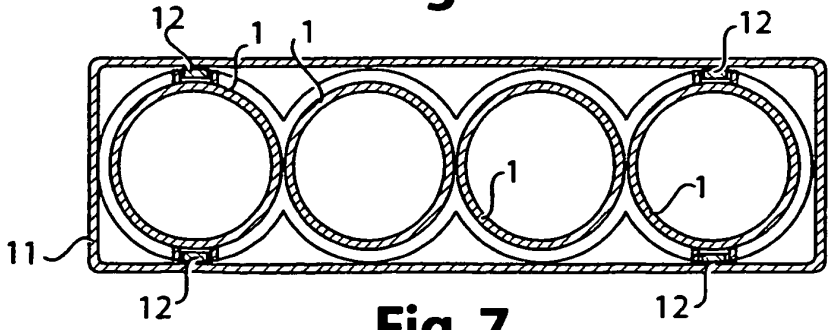

Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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